WHAT IS CLAIMED IS:

1. A size checking method comprising:

a first step of reading image data on a reference pattern and recognizing an edge direction of the reference pattern on the basis of pixel values detected at edge portions which are end portions as viewed in the width direction of the reference pattern;

a second step of detecting edge points corresponding to the end portions as sub-pixels on the basis of the pixel values detected at the edge portions;

a third step of acquiring image data on a pattern under inspection;

a fourth step of reading the image data on the pattern under inspection and calculating a widthwise dimension of the pattern under inspection, from edge portions located at the same position as the edge portion whose widthwise dimension is calculated by use of the reference pattern; and

a fifth step of determining whether or not the pattern under inspection is defective on the basis of the widthwise dimension of the reference pattern and the widthwise dimension of the pattern under inspection.

2. A size checking method according to claim 1, further comprising:

a sixth step of preparing a frequency distribution with respect to a dimensional error obtained on the

basis of the widthwise dimension of the reference pattern and the widthwise dimension of the pattern under inspection, and varying a threshold value used in the first step when the edge points are detected as sub-pixels.

3. A size checking method according to claim 1, wherein the image data on the reference pattern is acquired by performing an operation on the basis of design data on the semiconductor wafer circuit pattern.

4. A size checking method according to claim 1, wherein said first step includes:

scanning a measurement window across the reference pattern;

making a search in different directions from a pixel of interest which is located inside an area of the measurement window; and

examining edge directions in the vicinity of the edge portions of the reference pattern on the basis of the directions in which the search is carried out, and recognizing a pair when templates of edge direction patterns show that the edge directions oppose each other.

5. A size checking method according to claim 1, wherein the first step includes:

scanning a measurement window across the reference pattern;

detecting edge directions of the reference

pattern;

making a search in different directions from a pixel of interest which is located inside an area of the measurement window, said different directions being an X direction, a Y direction orthogonal to the X direction, directions which form angles of $\pm 45^{\circ}$ with reference to the X and Y directions; and

examining edge directions in the vicinity of the edge portions of the reference pattern on the basis of the directions in which the search is carried out, and recognizing a pair when templates of edge direction patterns show that the edge directions oppose each other.

6. A size inspection method according to claim 1, wherein the first step includes:

scanning a measurement window across the reference pattern;

detecting an edge direction of the reference pattern;

making a search in different directions from a pixel of interest which is located inside an area of the measurement window, said different directions being an X direction, a Y direction orthogonal to the X direction, directions which form angles of $\pm 45^{\circ}$ with reference to the X and Y directions, directions of bisectors between each of these directions and the X and Y directions; and

examining edge directions in the vicinity of the edge portions of the reference pattern on the basis of the directions in which the search is carried out, and recognizing a pair when templates of edge direction patterns show that the edge directions oppose each other.

7. A size checking method according to claim 1, wherein said second step includes:

preparing a profile showing how pixel values are distributed in the width direction of the reference pattern, the pixel values corresponding to the edge portion whose edge direction is recognized, and detecting edge points as sub-pixels using a predetermined threshold value with respect to the profile.

8. A size checking method according to claim 1, wherein the pattern under inspection is a semiconductor wafer circuit pattern formed on a mask used in exposure processing.

9. A size checking method according to claim 1, wherein the fourth step include:

detecting edge points at each of edge portions which are end portions as viewed in the width direction of the pattern under inspection, said edge points being detected with respect to the edge portions located at the same position as the edge portions whose widthwise dimension is calculated by use of the reference pattern; and

calculating the widthwise dimension of the pattern under inspection, with the edge points as starting points.

10. A size checking method according to claim 1, wherein said fifth step includes:

calculating a dimensional error on the basis of the difference between the widthwise dimension of the pattern under inspection and the widthwise dimension of the reference pattern; and

determining an abnormal state when a value obtained by adding an offset value to the dimensional error is out of an allowable range.

11. A size checking method according to claim 1, wherein said fifth step includes:

calculating a dimensional error on the basis of the difference between the widthwise dimension of the pattern under inspection and the widthwise dimension of the reference pattern; and

determining an abnormal state when a value obtained by adding an offset value to the dimensional error is out of an allowable range, and

said sixth step includes:

preparing a frequency distribution with respect to the dimensional error, which is based on both the widthwise dimension of the pattern under inspection and the widthwise dimension of the reference pattern; and

varying the offset value or a threshold value

which is that of either the reference pattern or the pattern under inspection, and which used in the second step when the edge points are detected as sub-pixels, on the basis of the frequency distribution.

12. A size checking method comprising:

acquiring a reference pattern by performing an operation on the basis of design data on a semiconductor wafer circuit pattern;

scanning a measurement window across image data on the reference pattern;

making a search in different directions from a pixel of interest which is located inside an area of the measurement window, said different directions being an X direction, a Y direction orthogonal to the X direction, directions which form angles of $\pm 45^{\circ}$ with reference to the X and Y directions;

detecting a search direction in which a pair of pixels are detected, on the basis of results of the search, and recognizing a direction orthogonal to the search direction as an edge direction of the reference pattern;

preparing a profile showing how pixel values are distributed in the width direction of the reference pattern, the pixel values corresponding to a pair of pixels whose edge direction is recognized;

detecting edge points corresponding to ends of the reference pattern as sub-pixels using a predetermined

threshold value with respect to the profile;

calculating a widthwise dimension of the reference pattern from the edge points;

acquiring image data on the pattern under inspection, the pattern being a semiconductor wafer circuit pattern formed on a mask used by an exposure apparatus;

calculating a widthwise dimension of the reference pattern at the same position as a pair of pixels whose widthwise dimension is calculated by use of the reference pattern;

calculating a dimensional error on the basis of the difference between the widthwise dimension of the pattern under inspection and the widthwise dimension of the reference pattern;

determining an abnormal state when a value obtained by adding an offset value to the dimensional error is out of an allowable range;

preparing a frequency distribution with respect to the dimensional error; and

varying the offset value or a threshold value which is that of either the reference pattern or the pattern under inspection, on the basis of the frequency distribution.

13. A size checking apparatus comprising:

pattern recognition means for reading image data on a reference pattern and recognizing an edge

direction of the reference pattern on the basis of pixel values detected at edge portions which are end portions as viewed in the width direction of the reference pattern;

first size-measuring means for detecting edge points corresponding to the end portions as sub-pixels on the basis of the pixel values detected at the edge portions, and for calculating a widthwise dimension of the reference pattern, from the edge points as starting points;

means for acquiring image data on the pattern under inspection;

second size-measuring means for reading the image data on the pattern under inspection and for calculating a widthwise dimension of the pattern under inspection, from edge portions located at the same position as the edge portion whose widthwise dimension is calculated by use of the reference pattern; and

means for determining whether or not the pattern under inspection is defective on the basis of the widthwise dimension of the reference pattern and the widthwise dimension of the pattern under inspection.

14. A size checking apparatus according to claim 13, further comprising threshold value-varying means for preparing a frequency distribution with respect to the dimensional error of the reference pattern and for varying a threshold value which the

first size-measuring means uses when the edge points are detected as sub-pixels, on the basis of the frequency distribution.

15. A size checking apparatus according to claim 13, further comprising data expansion means for acquiring image data on the reference pattern by performing an operation on the basis of design data on the semiconductor wafer circuit pattern.

16. A size checking apparatus according to claim 13, wherein said pattern recognition means includes:

means for scanning a measurement window across the reference pattern;

means for detecting an edge direction of the reference pattern;

means for making a search in different directions from a pixel of interest which is located inside an area of the measurement window; and

means for examining edge directions in the vicinity of the edge portions of the reference pattern on the basis of the directions in which the search is carried out, and for recognizing a pair when templates of edge direction patterns show that the edge directions oppose each other.

17. A pattern recognition means according to claim 13, wherein said pattern recognizing means includes: means for scanning a measurement window

across the reference pattern;

means for detecting an edge direction of the reference pattern;

means for making a search in different directions from a pixel of interest which is located inside an area of the measurement window, said different directions being an X direction, a Y direction orthogonal to the X direction, directions which form angles of $\pm 45^{\circ}$ with reference to the X and Y directions; and

means for examining edge directions in the vicinity of the edge portions of the reference pattern on the basis of the directions in which the search is carried out, and for recognizing a pair when templates of edge direction patterns show that the edge directions oppose each other.

18. A size inspection apparatus according to claim 13, wherein said pattern recognition means includes:

means for scanning a measurement window across the reference pattern;

means for detecting an edge direction of the reference pattern;

means for making a search in different directions from a pixel of interest which is located inside an area of the measurement window, said different directions being an X direction, a Y direction

orthogonal to the X direction, directions which form angles of $\pm 45^{\circ}$ with reference to the X and Y directions, directions of bisectors between each of these directions and the X and Y directions; and

means for examining edge directions in the vicinity of the edge portions of the reference pattern on the basis of the directions in which the search is carried out, and for recognizing a pair when templates of edge direction patterns show that the edge directions oppose each other.

19. A size checking apparatus according to claim 13, wherein said first size-measuring means prepares a profile showing how pixel values are distributed in the width direction of the reference pattern, the pixel values corresponding to the edge portion whose edge direction is recognized, and said first size-measuring means subsequently detects edge points as sub-pixels using a predetermined threshold value with respect to the profile.

20. A size checking apparatus according to claim 13, wherein the pattern under inspection is a semiconductor wafer circuit pattern formed on a mask used by an exposure apparatus.

21. A size checking apparatus according to claim 13, wherein said means for acquiring the image data on the pattern under inspection is provided with:

an exposure apparatus having a mask on which

a semiconductor wafer circuit pattern is formed;

imaging means for imaging a mask image projected by the exposure apparatus; and

image processing means for deriving image data from image signals output from the imaging means.

22. A size checking apparatus according to claim 13, wherein the dimensional error determination means is provided with:

means for calculating a dimensional error on the basis of the difference between the widthwise dimension of the pattern under inspection and the widthwise dimension of the reference pattern; and

means for determining an abnormal state when a value obtained by adding an offset value to the dimensional error is out of an allowable range.

23. A size checking apparatus according to claim 13, wherein said dimensional error determination means is provided with:

means for calculating a dimensional error on the basis of the difference between the widthwise dimension of the pattern under inspection and the widthwise dimension of the reference pattern; and

means for determining an abnormal state when a value obtained by adding an offset value to the dimensional error is out of an allowable range,

said threshold value-varying means includes is provided with:

means for preparing a frequency distribution with respect to a dimensional error; and

means for varying a threshold value which is used in the second step when the edge points are detected as sub-pixels, on the basis of the frequency distribution.

24. A size checking apparatus comprising:

data expansion means for acquiring a reference pattern by performing an operation on the basis of design data on a semiconductor wafer circuit pattern;

scanning means for scanning a measurement window across image data on the reference pattern;

search means for making a search in different directions from a pixel of interest which is located inside an area of the measurement window, said different directions being an X direction, a Y direction orthogonal to the X direction, directions which form angles of $\pm 45^\circ$ with reference to the X and Y directions; and

edge direction recognition means for detecting a search direction in which a pair of pixels are detected, on the basis of results of the search, and for recognizing a direction orthogonal to the search direction as the edge direction;

profile acquiring means for preparing a profile showing how pixel values are distributed in the width direction of the reference pattern, the pixel values corresponding to the edge portion whose edge direction

is recognized;

edge point-detecting means for detecting edge points corresponding to end portions of the reference pattern as sub-pixels using a predetermined threshold value with respect to the profile;

first widthwise dimension means for calculating a widthwise dimension of the reference on the basis of the edge points;

an exposure apparatus having a mask on which a semiconductor wafer circuit pattern is formed;

imaging means for imaging a mask image projected by the exposure apparatus;

image processing means for deriving image data on the pattern under inspection, from image signals output from the imaging means;

second widthwise dimension means for receiving the image data acquired by the image processing means and for calculating a widthwise dimension of the pattern under inspection, at the same position as a pair of pixels detected by the edge direction recognition means;

dimensional error calculating means for calculating a dimensional error on the basis of the difference between the widthwise dimension of the pattern under inspection and the widthwise dimension of the reference pattern;

determination means for determining an abnormal

state when a value obtained by adding an offset value to the dimensional error is out of an allowable range;

frequency distribution-preparing means for preparing a frequency distribution with respect to the dimensional error; and

varying means for varying the offset value or threshold value which is that of either the reference pattern or the pattern under inspection, on the basis of the frequency distribution.

25. A mask manufacturing method comprising:

a first step of preparing a mask having a base plate on which a circuit pattern of a semiconductor device is formed;

a second step of preparing first image data on a reference pattern, on the basis of design data on the circuit pattern of the semiconductor device;

a third step of preparing second image data on the circuit pattern by projecting light on the mask and acquiring a projected image of the mask;

a fourth step of reading image data on a reference pattern and recognizing an edge direction of the reference pattern on the basis of pixel values detected at edge portions which are end portions as viewed in the width direction of the reference pattern;

a fifth step of detecting edge points corresponding to the end portions as sub-pixels on the basis of the pixel values detected at the edge portions, and

calculating a widthwise dimension of the reference pattern, from the edge points as starting points;

a sixth step of reading the image data on the circuit pattern and calculating a widthwise dimension of the circuit pattern from edge portions located at the same position as the edge portion whose widthwise dimension is calculated by use of the reference pattern; and

a seventh step of determining whether or not the circuit pattern is defective on the basis of the widthwise dimension of the reference pattern and the widthwise dimension of the circuit pattern.

26. A mask manufacturing method according to claim 25, further comprising:

an eighth step of preparing a frequency distribution with respect to the dimensional error between the widthwise dimension of the reference pattern and the widthwise dimension of the circuit pattern and varying a threshold value based on which the edge points are detected as the sub-pixels in said fourth step, said threshold value being varied on the basis of said frequency distribution.

27. A mask manufacturing method according to claim 25, wherein said fourth step includes:

scanning a measurement window across the reference pattern;

detecting an edge direction of the reference

pattern;

making a search in different directions from a pixel of interest which is located inside an area of the measurement window; and

examining edge directions in the vicinity of the edge portions of the reference pattern on the basis of the directions in which the search is carried out, and recognizing a pair when templates of edge direction patterns show that the edge directions oppose each other.

28. A mask manufacturing method according to claim 25, wherein said fourth step includes:

scanning a measurement window across the reference pattern;

detecting an edge direction of the reference pattern;

making a search in different directions from a pixel of interest which is located inside an area of the measurement window, said different directions including an X direction, a Y direction orthogonal to the X direction, and directions which form angles of $\pm 45^{\circ}$ with reference to the X and Y directions; and

examining edge directions in the vicinity of the edge portions of the reference pattern on the basis of the directions in which the search is carried out, and recognizing a pair when templates of edge direction patterns show that the edge directions oppose each

other.

29. A mask manufacturing method according to claim 25, wherein said first step includes:

scanning a measurement window across the reference pattern;

detecting an edge direction of the reference pattern;

making a search in different directions from a pixel of interest which is located inside an area of the measurement window, said different directions including an X direction, a Y direction orthogonal to the X direction, directions which form angles of $\pm 45^\circ$ with reference to the X and Y directions, and directions of bisectors bisectors between each of these directions and the X and Y directions; and

examining edge directions in the vicinity of the edge portions of the reference pattern on the basis of the directions in which the search is carried out, and recognizing a pair when templates of edge direction patterns show that the edge directions oppose each other.